

## Technology of producing impressed filters to encompass two layers of aquifers

### Tehnologija izdelave vtisnega filtra v dva paketa vodonosnikov

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**Abstract:** To ensure safe excavation under aquifers it is necessary to employ drainage in order to decrease water pressure in the aquifers above the coal layer. In calculating the permissible height values of excavation, water pressure is one of the most important input data. To obtain real data it is necessary to provide suitable monitoring of the water pressure, which is an indicator of water drainage efficiency. To improve the effects of drainage by using jetted dewatering boreholes, a possible solution was either to install more impressed filters on a shorter distance, or to encompass two aquifers simultaneously through one borehole. We have gradually developed a novel technology of constructing jetted dewatering boreholes also which could encompass two aquifers. This technology can significantly reduce the costs for mine water drainage.

**Izvlček:** Za zagotavljanje varnega odkopavanja pod vodonosnimi plastmi je potrebno v največji možni meri z odvodnjevalnimi procesi znižati tlake vode v vodonosnikih nad premogovim slojem. Tlak vode je tudi eden izmed glavnih vhodnih podatkov pri izračunu dovoljenih višin odkopavanja, zato je za pridobitev realnih podatkov potrebno izvajati tudi ustrezen monitoring gibanja tlakov vode, ki so kazalec učinkov odvodnjevanja. Za izboljšanje učinkov odvodnjevanja z vtisnimi filtri, vidimo rešitev predvsem v povečanju gostote izdelave vtisnih filtrov ali v zajemanju dveh vodonosnikov hkrati na eni vrtini. Tako smo razvili popolnoma novo tehnologijo izdelave vtisnih filtrov, ki omogočajo zajem dveh vodonosnikov. Tehnologija zajema dveh vodonosnikov, pomeni tudi občutno znižanje stroškov jamskih odvodnjevalnih objektov.

**Key words:** drilling, two aquifers, jetted dewatering boreholes

**Ključne besede:** vrtanje, dva vodonosnika, vtisni filter

## INTRODUCTION

To ensure safe excavation under aquifers it is necessary to employ drainage in order to decrease water pressure in the aquifers above the coal layer. In calculating the permissible height values of excavation, water pressure is one of the most important input data. To obtain real data it is necessary to provide suitable monitoring of the water pressure, which is an indicator of water drainage efficiency. Due to the excavation in the north-western part of the Preloge coal field, the system of surface piezometers and drift filters has been damaged. Therefore, it was necessary to find a suitable replacement for the system. A good solution to overcome this problem was to install jetted dewatering boreholes, which would replace the drainage system. Since 1990, we have used the technology of vertical and inclined jetted dewatering boreholes by drilling with filter pipes into a single aquifer in the Velenje Coal Mines. In the Škale coal field, intensive drainage from the hanging wall aquifers with in-mine boreholes has been practiced since 1960. To reduce drilling in the cave, the jetted dewatering boreholes, based on drilling technology using screens, is functionally less efficient than the object - a drift filter, which is made from the surface. To improve the effects of drainage by using jetted dewatering boreholes, a possible solution was either to install more impressed filters on a shorter distance, or to encompass two aquifers simultaneously through one borehole. Drilling with screens is possible if an inner tube is installed in the screen which will direct the flow of the drilling fluid directly through the drilling crown. During the activation procedure this part is removed.

To make the drainage processes more efficient, a suitable solution was to design an jetted dewatering boreholes, which would simultaneously encompasses two aquifers through one borehole, provided that the two aquifers have no hydraulic impact on one another. With this in mind, we have gradually developed a novel technology of constructing jetted dewatering boreholes also which could encompass two aquifers. This technology can significantly reduce the costs for mine water drainage.

## GEOLOGICAL AND HYDROGEOLOGICAL CONDITIONS

### Geological characteristics of the Velenje Coal Mines

The Velenje depression is of tectonic origin. It was formed already in the Helvet, however, the formation of sediments above the pre-pliocenic layers occurred during the period of late Miocene and at the beginning of Pliocene, during which, due to a series of neotectonic fractures, the whole territory of the Velenje-Dobrnik region sank. This resulted in a depression, which was formed between the Smrekovec and Šoštanj fracture, which is meshed with local fractures of different ages, going in all directions. The valley, as seen today, has been formed by sinking and simultaneous deposition of sediments, and the coal layer has been formed along its synclinal shape. This layer extends over an area which is approx. 8.3 km long and 1.5 to 2.5 km wide. The coal layer is closest to the surface on the edges of the valley, and deepest in the centre, where it reaches a thickness of 168 m, yielding high quality coal.

The layers, which were accumulated by settling of sediments into the depression, represent a complete sedimentation cycle: from the land phase, to marsh land, and lake sedimentation, and back to marsh and land phase. This sequence is frequently broken by fluviatile sediments, sand, and gravel which had been drifted from the north and north-west.

Basically, the geological picture of the Velenje synclinal valley consists of Plioquaternary hanging wall layers, a coal layer, Pliocene layers in the footwall, and a pre-Pliocenic basement.

#### Hanging wall strata

The Plioquaternary strata in the hanging wall of the Velenje synclinal valley consist of a series of layers of sand, sand with gravel, silt, arenaceous and clayey silts, arenaceous clays, clays, siltstone and claystone, intertwined in vertical and horizontal direction, thus forming a unique multilayer system, which on the vertical line consists of more than a hundred of layers of different thickness. This sedimentary sequence of the hanging wall is mainly in the central, northern and western part of the synclinal valley, while on the southern and eastern part, the hanging wall consists mainly of clays and claystones silts and siltstones.

#### Coal layer

The coal layer needs to be considered as complex system, consisting of sequences of "Plioquaternary formations" (basement layer, direct footwall, coal layer, Pliocene hanging wall and Pleistocene hanging wall strata), which are typical for orogenic active zones. After a short transport period,

coarse-grained clastites were deposited from the north-west into the intramontane depression where a lake was formed.

On the eastern side, where the possibilities of open-pit mining and underground coal gasification have been considered, the coal layer is relatively poor in terms of quality. However, at the opposite end, on the west, the coal layer dips into depth, becomes thicker, and has better quality. The north-eastern edge is characterised by a steep Triassic slope, where the coal layer becomes thinner and turns upwards. At some places the coal directly contacts the Triassic strata. In the central part on the north, and north-west, numerous layers of clay and sand penetrate into the coal layer. Towards south, these layers become thinner and tail out. In this area too, sand layers can be found in the hanging wall.

In Topolšica (on the western side) the coal layer slightly turns up, becomes thinner and tails out. The southern edge of the depression lies directly on the Šoštanj fracture zone, which can be clearly seen from the shape of the coal layer in this area. We can observe sudden changes and interruptions of the layer. In the central part the layer of coal is deepest and of high quality, reaching maximum thickness of 168 metres.

#### The footwall Pliocene strata

The pre-Pliocene basement is directly covered by basal layers consisting of green arenaceous silts and sands, while above the triassic layers there is some red and grey clay, followed by direct footwall of a similar formation, with increased content of clay.

### Pre-Pliocene basement

A great part of the pre-Pliocene basement of the Velenje synclinal valley, as well as the most of the eastern, northern and north-western edge of the valley is composed of Triassic strata of various ages and lithology. Triassic strata, particularly those from middle and upper Triassic period, are limestone and dolomites, which make up a system of aquifers. The system is useful for supplying water, however, it also represents a risk for the mine water inrushes due a close proximity of the mine workings and a thin protective layer.

The central and southern part of the synclinal valley is composed of Oligocene materials (andezite with tuff and breccia) and Miocene sediments (sandstone and lithothamnian limestone). Oligocene sediments and Miocene sandstone are impervious and thus not a problem from the hydrogeological point of view. The Miocene lithothamnian limestone is an aquifer, however, it covers only a limited area in this mine. In addition, it is not renewed with water, therefore it is irrelevant in this situation.

### **A brief description of hydrogeological problems in the Velenje Coal Mines**

The geological description of the site shows that the Velenje coal mine consists of two main types of aquifers: the Pliocene gravely-sandy aquifers in the hanging wall, and Triassic (dolomites prevailing) in the footwall. There have been no problems with water during excavations in the southern region of the synclinal valley of the mine since there are no aquifers which could have impact on the excavations, neither in the hanging wall, nor in the footwall. However, the situation is dif-

ferent in the central, western, northern and eastern parts: the Preloge coal field lies in the northern part, and the Leženj region is situated on the east. The layer of clay between the coal and the water-bearing sands is very thin, only a few metres thick. Due to high water-pressure in the water-bearing sands lying above the coal, these aquifers represent a potential danger for water and quicksand inrush during excavations, and consequently mean direct risk for safe mining. Since the hanging wall consists of a multi-layer system of aquifers, where individual layers are not necessarily connected, the distribution of pressure in these aquifers varies. This means that hydrodynamic properties of the layers are different too.

Because of the potential danger of water and quicksand inrushes, from sandy to silty aquifers close to the hanging wall, it was necessary to decrease water pressure in the lower part of the hanging wall aquifers system to ensure safe mining and to meet the criteria for safe mining (KOČAR et al., 1989) to avoid the risk of water inrush. In the period from 1979 to 1988, 36 drift filters were installed in the Velenje coal mine to drain water from the Pliocene hanging wall aquifers. The filters were placed in the following mine dewatering roadways named barrage roadway: central barrage roadway (drift filters V-9o to VO-9), north-western barrage roadway (drift filters BV-2 to BV-13), northern barrage roadway (drift filter BV-20), the barrage roadway running along the synclinal valley (drift filters V-11n to V-12z), and southern barrage roadway, or southern barrage upraise roadway (drift filters BV-22 to BV-31). The central barrage roadway was

constructed as an experimental roadway already in the period from 1979 to 1981, while other drift filters were constructed later and finished in 1988. Since 1984, the central barrage roadway has been connected with the drainage pipeline system in the PV coal mine. These drift filters are still operating on this roadway, draining the water coming from complex Pliocene hanging wall aquifers. Other drift filters were gradually connected to the drainage system in the mine, and since 1996 they have been serving in this purpose.

The design of the drainage system was made based on the experience and knowledge, gained during the experimental drainage in the period 1964-1972. During this period numerous wells for gravitational drainage of water from the hanging wall aquifers into the mine, were made in the Leženj area, together with installation of a series of dewatering boreholes (105 objects), which additionally contributed to decrease the water pressure in the sands above the coal, particularly in the areas where surface drainage system, could not be implemented due to excavation operations.

The drainage technology, which was used in the period from 1979 to 1988, was selected upon previous experience and the technology which was used 20 years before that, using submersible pumps to pump water from the wells to the surface (wells NV-1 to NV-4). At that time it was proved that the most efficient method of water drainage is gravitational drainage of water from the hanging wall aquifers via drift filters into the mine.

However, hydrogeological conditions above the Šoštanj coal field demanded a different approach to deal with the problem of water drainage. Thus, two wells for pumping water to the surface were constructed during 1998 and 1999 (BV-23 and BV-24), using the so called MOYNO pumps.

Considering that before any drainage operation, the levels of water throughout the Plioquaternary formations are approximately the same, the drainage of water from the hanging wall aquifers would result in lowering the water level: in the sand layers directly above the coal (and the layers above sand) the level would decrease for more than 350 metres, in the upper layers from 100 m to 150 m, depending on whether the aquifer has been drained directly, or indirectly (by leakage from the superimposed layers). In the Quaternary layers the impact of drainage has not been noticed since these layers were not directly drained. Due to the intermediary sealing layers the connection with the underlying Pliocene layers, is too weak.

By simulation of the drainage processes using a mathematical model (1995, 1998) it was proved that, in order to maintain low water-pressure in the sands directly above the coal seam, a good drainage of several subsequent water bearing layers overlying these sands would be needed. Nowadays, in the Preloge coal field, a great part of the drainage system has been abandoned due to coal excavations (the whole central barrage roadway, some wells from the barrage roadway along the synclinal valley, and north-western and northern barrage

roadway). Consequently, the quality of the drainage system in the hanging wall layers has deteriorated: the drainage process has become relatively slow and the effects of the elimination of the drainage will only become evident in the near future.

In addition to this, there have been some problems with the drainage from both wells used for pumping water to the surface. This calls for the construction of substitutional mine drainage facilities, which would partially replace the drainage by drift filters. For this purpose we developed a technology of a double screen jetted dewatering boreholes, which is presented further on.

#### TECHNOLOGICAL IMPLEMENTATION OF A DOUBLE SCREENED JETTED DEWATERING BOREHOLES

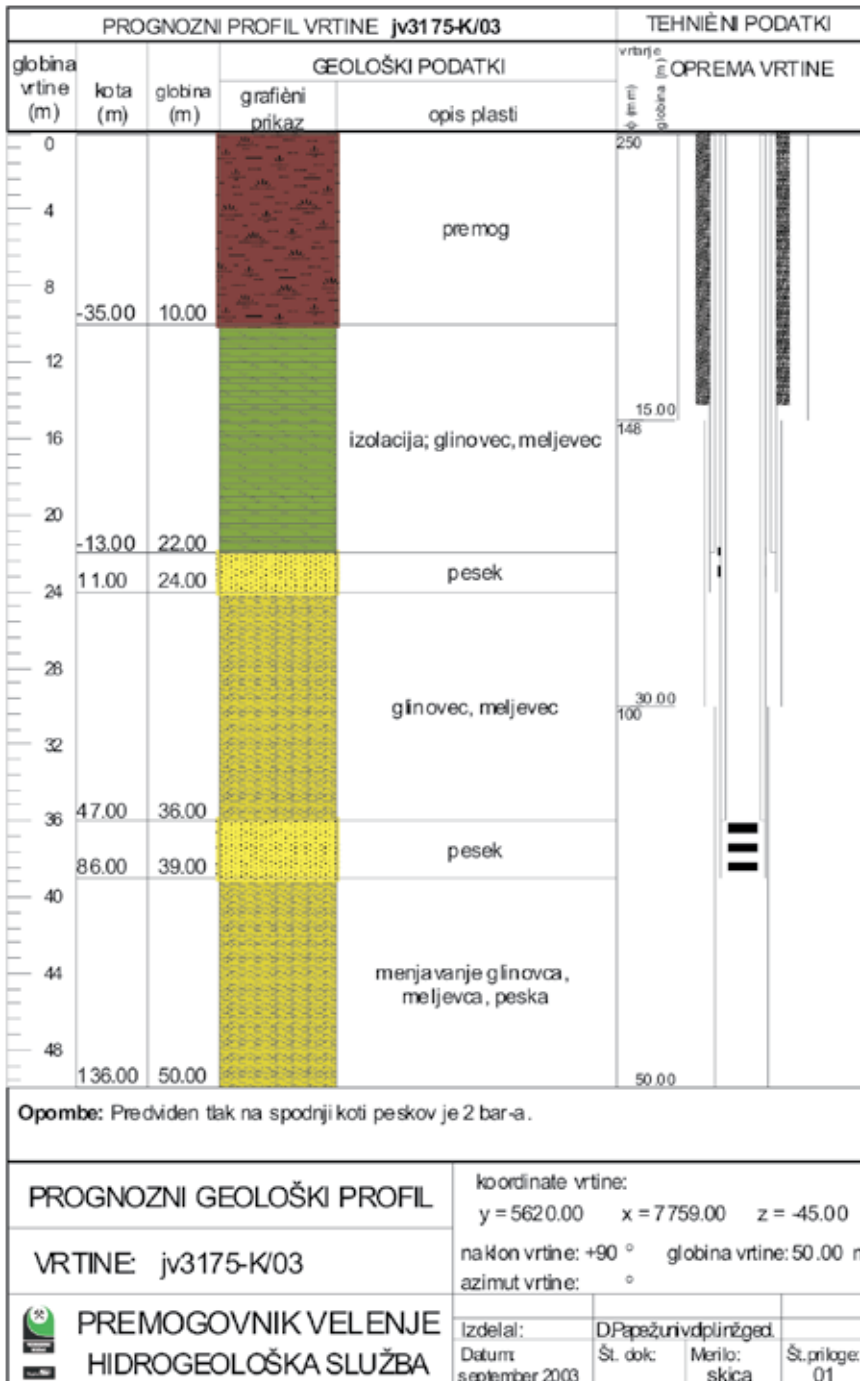
Conventional methods for constructing dewatering boreholes are frequently unreliable due to high pore pressure which occurs in the aquifers. Thus, already in constructing the jetted dewatering boreholes for a single aquifer we developed a technology which is based on cemented technical pipes and drilling with pipe-screen which is built in the aquifer (VESELIĆ et al., 1991; VUKELIĆ, 2005). Drilling with pipe-screen, can be made if an inner pipe is installed into the screen, which will direct the flow of the drilling fluid through the drilling crown. During the activation procedure this part is removed. To rationalise the drainage processes and to improve the effects of drainage it was necessary to consider the construction of a jetted dewatering borehole, which would use one borehole and simul-

taneously encompass two aquifers, provided that in terms of hydraulics the two aquifers would not interfere with one another (VUKELIĆ, 2005). The technology was developed and tested in the Velenje coal mine in the borehole No. JV 3175–K/03, located on the transport roadway of the excavating plates G1/B in the north-western part of the Preloge cave. The location is presented in Figure 2. There are two factors which are crucial for a successful implementation of the technology: good understanding of hydrogeological conditions and good geological prognosis. The geological prognostic profile of the borehole JV 3175–K/03 is presented in Figure 1. The main feature of this new technology is that drilling is not interrupted after installing the first screen with a larger diameter into the first layer of sands above the coal: drilling can be continued by loosening the drilling crown and activating the screen in the first aquifer. After the screen has been activated, drilling is continued using the first screen and related pipes as liner to the subsequent aquifer. Drilling is performed with a filter with  $\phi 73$  mm diameter through the pipe with  $\phi 128$  mm diameter. After the filter has been installed in the second layer of sand, it is activated. Figure 3 presents the installation of the jetted dewatering borehole into two aquifer layers.

#### **Installation procedure of the jetted dewatering borehole into two layers of aquifers**

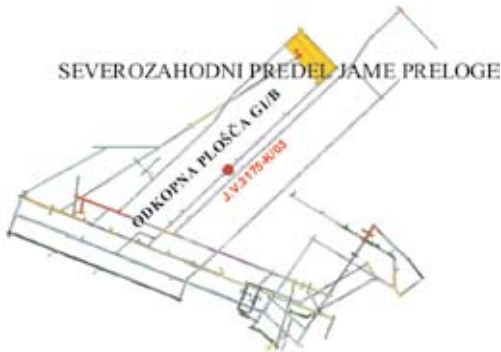
##### *Construction of the conductor pipe*

The conductor pipe is made in a standard way. A borehole for the conductor pipe is drilled with a drilling crown which is



**Figure 1.** Geological prognostic profile of the borehole JV 3175–K/03

**Slika 1.** Prognozni geološki profil vrtine JV 3175–K/03



**Figure 2.** Location of the borehole JV 3175–K/03

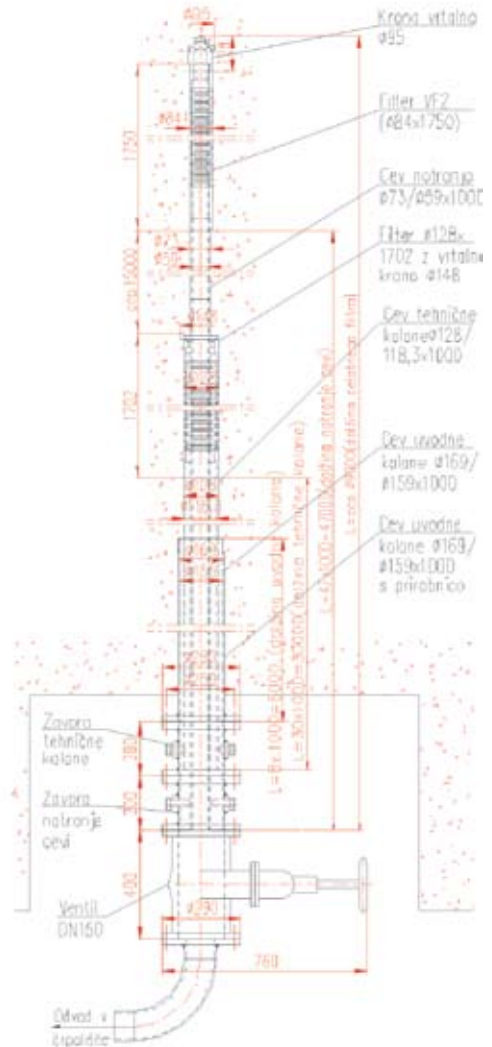
**Slika 2.** Lokacija vrtine JV 3175–K/03

then cased with the conductor pipe. The length and the diameter of the conductor pipe will depend on the length of the jetted dewatering borehole and water pressure in the aquifers lying above the coal. Next, a tightness test of the conductor pipe needs to be carried out: water is pushed into the borehole via the liquidation flange with 50 % greater pressure than the maximum anticipated water pressure in the aquifers. If the borehole does not provide the desired tightness, cement slurry needs to be injected, or the edges of the borehole need to be sealed down with cement. After completing the tightness test, and before proceeding with drilling, it is necessary to fit the mouth of the borehole with tube brakes, and a valve, as shown in Figure 4.

### *Drilling and installation of the filter into the first aquifer*

Drilling through the conductor pipes is carried out in a standard way, using drilling pipes with diameter of  $\phi 128$  mm and a double-layer screen with  $\phi 128/113$  mm diameter. The drilling crown of the screen is composed of two parts: a fixed crown

with cutting diameter of  $\phi 148$  mm, which remains on the screen, and a removable crown fixed to the seal pipe. After fixing the swivel pipe behind the valve (the swivel needs to correspond with the diameter of



**Figure 3.** Installation of the jetted dewatering borehole into aquifers

**Slika 3.** Shematski prikaz vtisnega filtra v dveh paketih vodonosnikov





**Figure 4.** A flange of the conductor pipe, brakes, a valve, and a swivel pipe  
**Slika 4.** Prirobnica uvodne kolone, zavore, zaporni zasun in izlivka

the pipe of  $\phi 128$  mm), drilling can be continued to a desired depth using a suitable polymer drilling fluid. In the Velenje coal mine we used Modipol 600, a polymer additive (powder), or Argipol, which is a liquid polymer additive. The first layer of the aquifer is activated by loosening the seal head and the removable crown. Figure 5 shows an adapted transportable unit K1 for preparing the drilling fluid, while Figure 6 shows the first filter with diameter of 128 mm with the drilling crown (cutting diameter 148 mm), and the removable crown.

### ***Drilling and installation of the screen into the second aquifer***

Further drilling to reach the second water-bearing sand layer, is made through the screen which has been installed and activated. Drilling is performed by using screen VF2, which consists of the filtering part with  $\phi 84$  mm diameter and a cutting crown of  $\phi 95$  mm. The screen is connected with the drilling pipes with  $\phi 73$  mm diameter. In case the material between the first and the second aquifer is harder, it is possible to modify the technology so as to achieve faster drilling, using a pyramid drill. When the desired length of the borehole has been achieved it is necessary to remove the pyramid drill and reinsert jet-in screen, with  $\phi 84$  mm /  $\phi 95$  mm with drilling pipes  $\phi 73$  mm. After that, the screen is activated using the general procedure.



**Figure 5.** Preparation of the drilling fluid  
**Slika 5.** Priprava izplake



**Figure 6.** Filter with  $\phi 128$  mm diameter, a drilling crown with cutting diameter of  $\phi 148$  mm, fixed to the screen, and removable crown  
**Slika 6.** Filter premera  $\phi 128$  mm, vrtna krona z rezalnim premerom  $\phi 148$  mm, ki je fiksirana na filtru in izvlačljiva krona

#### EQUIPMENT FOR THE CONSTRUCTION OF JETTED DEWATERING BOREHOLE INTO TWO AQUIFER LAYERS

The following equipment is needed for the construction of jetted dewatering borehole:

• a RVS-Max drill	45 kW
• ČGZ 250 Pump, or TRIDO 220 pump	22 kW
• Submersible pump [3 m <sup>3</sup> /min]	37 kW
• Flygt Submersible pump	2.9 kW
• suitable pipe armature	
• telephone	
• illumination of the worksite	
• supply of technological water and wastewater drainage	

#### RVS-Maxdrill

The RVS-Max drill is used for drilling in mine workings and in methane conditions, and particularly for drilling of boreholes for the drainage from water-bearing layers. The RVS-Max drill is manufactured by HTZ Velenje.

#### Basic components of the RVS-Maxdrill

1. Hydraulic drive unit (Figure 7), which is an independent transportable unit, driven by a 45 kW (500 V) electric engine. Secondary drive is provided by two hydraulic pumps.
2. A mast with integrated extension and double clamping jaws (Figure 8). The mast facilitates the movement of the carriage with rotation head and provides movement of the drilling pipes forward and backward during drilling. The stroke-length of the head allows for the use of pipes with 1500 mm in length. The pull-down and the pull-back force is transmitted to the pipes via a hydraulic cylinder and a stud-link chain Wipermann  $\frac{3}{4}$ ". The extension of the mast is integrated, with double clamping jaws attached to it.
3. A system for fixing or supporting the mast (hydraulic - mechanical support).
4. Control panel with driving and control tools (Figure 9).
5. The rotation head on the carriage is a multi-stage reduction gear, driven by two hydro engines, which can be started in three different modes.



**Figure 7.** Hydraulic drive unit  
**Slika 7.** Pogonski hidravlični agregat



**Figure 8.** A mast with the rotation head, clamping jaws and the system for fixing the mast  
**Slika 8.** Lafeta z rotacijsko glavo, vpenjalnimi čeljustmi ter sistemom za vpetje lafete





**Figure 9.** Control desk  
**Slika 9.** Kontrolno krmilna plošča

### **Technical data**

Rotating head stroke	1500 mm
Mast length	2500 mm
Max. speed	0.3 m/s
Operating oil-pressure	180 bar
Max. thrust force	4500 N
Machine weight	1700 kg

Level	Moment [Nm]	Rotation [rev/min]
I (M1+M2)	3150	100
II (M2)	1240	254
III (M1)	1930	163

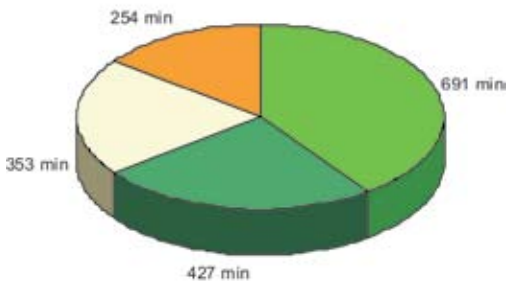
### **Clamping jaws: technical data**

	Clamping diameter [mm]	Clamping force [N]
Front jaws	42 - 73	6900
Rear jaws	89 - 163	6900

### **TIMEFRAME FOR THE CONSTRUCTION OF THE JETTED DEWATERING BOREHOLE**

The construction procedure of the jetted dewatering borehole for working through two aquifers is an upgraded version of the standard construction procedure such a borehole for a single aquifer. Additional time is required for installation of an additional brake, and preparation of the second screen and for drilling, activation of the second screen, etc.

In our case, the total time needed for drilling was 691 min, for pushing down and removing the drill pipes 427 min, and for auxiliary works 353 min. The distribution of time needed for various work-phases in installing both screens is presented in Graph 1 below.



Legend:

- drilling
- pulling back the drilling pipes
- auxiliary works
- deadlocks

**Graph 1.** Time distribution of the operations for the installation of two jet-in screens

**Diagram 1.** Čas trajanja delovnih faz pri vgradnji dveh filtrov

A more detailed time-frame is presented below:

Screen one: drilling: 548 min, pushing the drill pipes: 58 min, and auxiliary works 263 min.

Screen two: drilling: 143 min, pushing and removal drill pipes: 369 min, and auxiliary works: 90 min.

The auxiliary works included: preparation works, assembling and dismantling of the pipe brakes, the swivel, the valve, the sealing head, fixing the pipe brakes, etc.

The histogram below (Graph 2) shows the comparison between the duration of work phases in the first and the second screen instalation. A significant difference can be observed in the duration of drilling, and the time needed for pushing down and pulling back the drill pipes.

Drilling through the first water-bearing layer took more time than drilling through

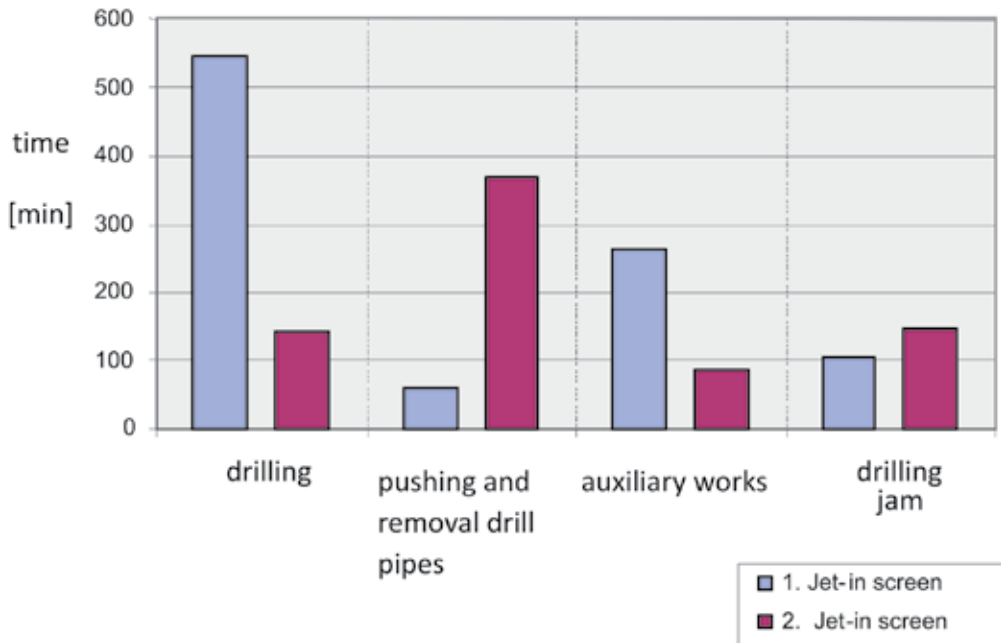
the second layer. The average drilling speed used for the first screen was 2.1 cm/min, and 2.0 cm/min for the second screen (drilling was performed at the length of only 2.45 m), and 39.2 cm/min for drilling with the drilling pyramid (for the second filter). The difference in time was also due to the different length of the boreholes in the first and the second screen.

During the emplacement of second jet-in screen, more time was spent for pushing and pulling out the drill pipes. This is because the screen was equipped with the drilling crown, and because more drill pipes which had to be inserted into or removed from the borehole.

We saved no time for the preparations of the drilling set and the worksite, and for removing the drilling set and cleaning the worksite, and preparation of the drilling fluid and construction of the conductor pipe. The total time needed for these operations was similar to any other drilling operations.

## CONCLUSIONS

To ensure safe mining under water-bearing layers it is necessary to provide drainage to minimise water pressure in the aquifers lying above the coal layer. Water pressure is one of the main entry data in calculating the permissible height of excavation. This means that it is necessary to introduce suitable monitoring methods to control changes in water pressure which is the indicator of the effects of drainage. Since by excavation works in the north-western part of the Preloge coal field the system of surface



**Graph 2.** Duration of work operations in installing the impressed filter into the aquifer 1 and 2

**Diagram 2.** Primerjava trajanja delovnih faz pri izdelavi vtisnega filtra v 1. oziroma v 2. vodonosnik

observation wells and drift filters has been damaged to a great extent, it was necessary to find a suitable replacement. This was done by installation of jetted dewatering boreholes. From the existing jetted dewatering boreholes, which dewater just one aquifer, we have developed a completely new technology for jetted dewatering boreholes installation which would drain two aquifers simultaneously, while each of the aquifers is drained separately. In this way we have significantly shortened the time needed for the construction of a jetted dewatering boreholes drainage system and thus made the construction of drainage facilities more cost-effective.

#### POVZETEK

Tehnologija izdelave vtisnega filtra v dva paketa vodonosnikov

Za zagotavljanje varnega odkopavanja pod vodonosnimi plastmi je potrebno v največji možni meri z odvodnjevalnimi procesi znižati tlake vode v vodonosnikih nad premogovim slojem. Tlak vode je tudi eden izmed glavnih vhodnih podatkov pri izračunu dovoljenih višin odkopavanja, zato je za pridobitev realnih podatkov potrebno izvajati tudi ustrezen monitoring gibanja tlakov vode, ki so kazalec učinkov odvodnjevanja. Ker si z odkopavanjem SZ

predela jame Preloge v veliki meri rušimo sistem površinskih piezometrov in visečih filtrov, je potrebno najti nadomestilo zanje. Rešitev se kaže v izdelavi nadomestnih jamskih objektov - vtisnih filtrov. Tehnologija izdelave vertikalnih in poševnih vtisnih filtrov z vrtnjem s cevmi filtra v en vodonosnik, je v jamah Premogovnika Velenje prisotna od leta 1990. Intenzivno odvodnjevanje krovinskih vodonosnikov z jamskimi vrtinami pa se je v jami Škale izvajalo že od leta 1960. Zaradi omejitev jamskega vrtnja, je vtisni filter izdelan po tehnologiji vrtnja s cevmi filtra funkcijsko slabši kot objekt - viseči filter, ki ga izdelamo iz površine. Za izboljšanje učinkov odvodnjevanja z vtisnimi filtri, vidimo rešitev predvsem v povečanju gostote izdelave vtisnih filtrov ali v zajemanju dveh vodonosnikov hkrati na eni vrtini. Vrtnje s cevmi filtra je možno, če v filtrski del vgradimo notranjo cev, ki usmerja tok izplake neposredno skozi vrtalno krono. Pri postopku aktivacije ta del izvlečemo. Zaradi racionalizacije odvodnjevalnih procesov in izboljšanja odvodnjevalnih učinkov, je bilo smiselno razmišljati o izvedbi vtisnega filtra, ki preko ene vrtine zajema dva vodonosnika hkrati, ob pogoju, da hidravlično ne vplivata drug na drugega. Tako smo razvili popolnoma novo tehnologijo izdelave vtisnih filtrov, ki omogočajo zajem dveh vodonosnikov. Tehnologija zajema dveh vodonosnikov, pomeni tudi občutno znižanje stroškov jamskih odvodnjevalnih objektov.

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